MARINE FISHERIES

Fishing in the ice: is it sustainable?

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A better knowledge of the biology and habits of the Antarctic toothfish is needed to manage a sustainable fishery for this species in the sensitive environment of Antarctica.

Teachers: this article can be used for NCEA Achievement Standards in Geography (1.7, 2.7, 3.7, 1.6, 2.6, 3.6), Biology (1.2, 1.5, 2.2, 2.5, 2.6, 2.9, 3.2). See other curriculum connections at www.niwa.co.nz/pubs/wa/resources

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In recent years an exploratory fishery for Antarctic toothfish has developed in the Ross Sea and in the Southern Ocean to the north. Fisheries in Antarctic waters are managed by CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources). CCAMLR takes a precautionary approach to fisheries management and also has a strong mandate from its members to take into account ecosystem effects of fishing. In conjunction with the Ministry of Fisheries (MFish) and New Zealand fishing companies, NIWA has been involved in developing research programmes to help ensure that the fishery is both sustainable and has minimal impact on the surrounding ecosystem.

Antarctic toothfish get very big. This one was 1.75 m long and weighed over 75 kg.

Photo: Stu Hanchet

The toothfish fishery

Antarctic toothfish (*Dissostichus mawsoni*) are **nototheniids** that can grow up to 2 m long and weigh up to 100 kg. They are caught from the Polar Convergence (at about 60°S) southwards to the Antarctic continent. The closely related Patagonian toothfish (*D. eleginoides*) are mainly caught north of 65°S. Between these latitudes both species are equally abundant. The Ross Sea region is unusual because both species are found there. In fact, over 90% of the longlines set in the fishery in this area catch both species on the same line. Both species are found to depths of over 2000 m.

The Ross Sea fishery is the southernmost fishery in the world, and ice conditions and extreme cold make fishing both difficult and dangerous. During most of the year the Ross Sea is covered by ice. However, during January and February areas of open water (called polynas) form, which enable access to the continental shelf and slope. Longline vessels from New Zealand, South Africa and Russia start working in the deep south at this time, but as sea ice forms they move north and by May are restricted to the northernmost fishing grounds. Antarctic toothfish has formed over 95% of the fishery's catch, which has steadily increased from about 40 t in 1998 to over 1800 t in 2003.

NIWA's research related to the toothfish in the Ross Sea has concentrated on catch sampling methods, genetics, age and growth, monitoring abundance, and measures to reduce bycatch and impacts on seabirds. Also, each year in October, NIWA staff travel to the CCAMLR Working Group on Fish Stock Assessment meetings held in Hobart, where stock assessments are conducted to estimate sustainable yields. In 2004, NIWA scientist Stuart Hanchet will take over as convenor of this working group for 2–3 years.

Toothfish biology

Although considerable research has been carried out elsewhere on Patagonian toothfish, little was known about the biology of Antarctic toothfish prior to 1999. With the help of US scientists we have developed a validated method for ageing Antarctic toothfish – the first for any toothfish species. For over 20 years, scientists at McMurdo Sound in the Ross Sea have tagged Antarctic toothfish and, before release, injected the fish with oxytetracycline. This chemical is deposited in the hard parts of the fish and acts as a date marker of when the fish was released. Recent recapture and analysis of six fish (including one that had been at liberty for 7 years) confirmed that rings in the otoliths (earbones) were formed annually. Toothfish grow quite fast – at a similar rate to temperate-water species such as hoki and hake. They reach about 60 cm long after 5 years, about 100 cm after 10 years, and about 150 cm

after 20 years. The maximum age recorded is almost 50 years, but few fish older than about 30 years are caught. It is thought that fish mature at about age 10.

Spawning is thought to occur in winter, but we do not know the exact timing and location as the Ross Sea area is ice-covered at that time. Some ripe fish have been found to the north of the area in May, so it is likely that spawning continues from then through to late winter. Larvae and juvenile fish are **pelagic** (until at least 15 cm long), after which they start to spend more time on the sea bottom.

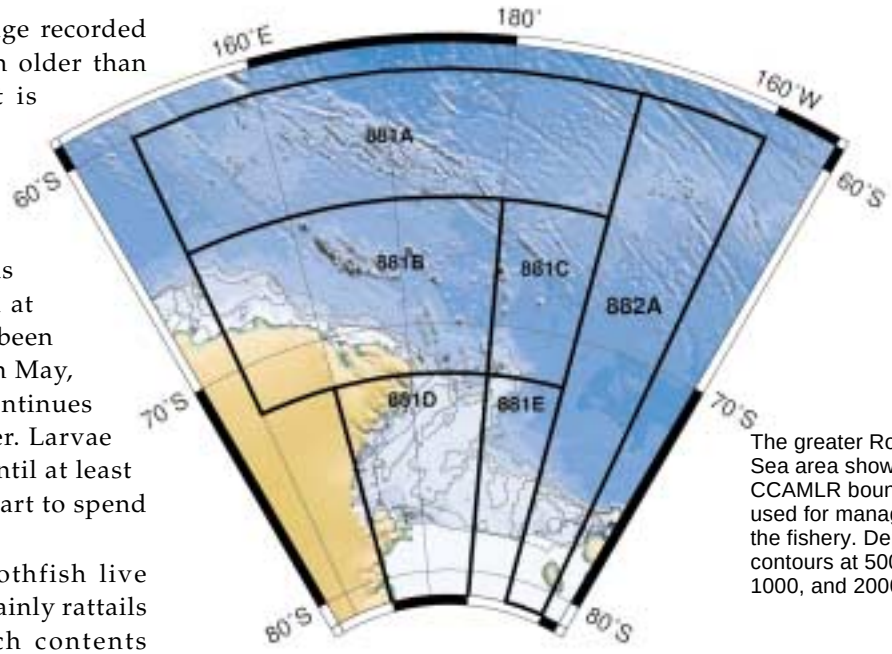
We have found that adult toothfish live mostly on a diet of other fish, mainly rattails and icefish. Unusual stomach contents recorded include three penguins, numerous skate egg cases, and a large quantity of rocks. Over 500 stomach samples were collected during the 2003 season and are currently being analysed to extend our knowledge of feeding and toothfish ecology.

Very little is known about the stock structure of Antarctic toothfish. However, NIWA will soon be studying the genetic relationships among populations in the Southern Ocean. DNA analyses should provide insight into whether there is genetic exchange among fish populations in different areas.

Management

In line with the CCAMLR policy of taking an ecosystem approach to managing fisheries, many management measures are in place to ensure minimal effects of the fishery on the environment. These include catch limits for toothfish and bycatch species, seabird and fish bycatch mitigation measures, and zero discard of any waste or offal.

NIWA has been involved in monitoring and characterising various aspects of the fishery including the toothfish catch, and the fish and invertebrate bycatch. In co-operation with the Museum of New Zealand Te Papa Tongarewa we have identified the main bycatch species as Whitson's grenadier and the starry skate, and have studied aspects of their biology including age, growth, length–weight, and maturity. We have also investigated ways to monitor their abundance and to minimise the bycatch.



The greater Ross Sea area showing the CCAMLR boundaries used for managing the fishery. Depth contours at 500, 1000, and 2000 m.

Elsewhere in the Southern Ocean, there has been a high incidental mortality of seabirds during longline fishing operations. To date no seabirds have been hooked in the Ross Sea fishery.

The greatest difficulty we currently face is the ability to monitor toothfish abundance in the greater Ross Sea area. Because of the pristine nature of the region, the large area and the extensive ice cover, most traditional monitoring methods – such as research trawl surveys, egg and larval surveys, acoustic surveys, and analysis of commercial catch per unit of effort (CPUE) data – are unsuitable. The most promising alternative method is a long-term tagging study. This involves the release of tagged fish from fishing vessels as a requirement of their fishing permits. NIWA is currently carrying out simulation studies to determine the number of releases needed for the method to be successful. Together with scientists from the Australian Antarctic Division, we are also using population models to simulate the effect of fishing on the Ross Sea toothfish population. Other methods such as acoustics have been tried but do not currently appear suitable for estimating stock size.

Perhaps the greatest challenge of all will be to understand potential impacts of this fishing on the ecosystem. NIWA will soon start pulling information together on the various aspects of the Ross Sea ecosystem and working collaboratively with other national and international scientists to better understand the ecosystem as a whole. Only then will we be able to fully answer the question of whether fishing in the ice is really sustainable. ■

For explanations of terms in **bold**, see glossary on page 23.

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